

REMARKS

Claims 1-4 and 12-75 are cancelled without prejudice to file a divisional application therefor. Claims 5-11 are pending.

Claims 5-11 have been amended to recite "multifilament yarn" in place of "multifilament" at the Examiner's suggestion. Support for the amendment is found in paragraphs [0106] to [0112] which describe a process for producing the "multifilament". To one of skill in the art, this process describes the process of producing what is known also as a multifilament yarn. No new matter has been introduced. Entry of the amendment is requested.

RESPONSE

REJECTION UNDER 35 USC §112, SECOND PARAGRAPH

Claims 5-11 were rejected for being unclear and indefinite in reciting "multifilament". As amended claims 5-11 now recite multifilament yarn. To those of skill in the art, multifilament yarn is also referred to as multifilament. As amended, the rejection of claims 5-11 on this basis is now moot.

REJECTION UNDER 35 USC §103(a)

A. Claims 5-8 were rejected for being obvious in view of JP10287735A.

It is contended that JP10287735A describes a polylactic acid prepared from D- and or L-lactic acid with 0.0001-0.003 mol % tin octoate as a catalyst.

Reconsideration of the rejection is requested for the following reasons.

The present invention of claims 5-8 is directed to a multifilament yarn made of a polylactic acid that is linear in structure of a specific relative viscosity that is prepared from at least 98% L-lactic acid.

A review of JP10287735A describes the preparation of a polylactic acid composition from lactic acid with a suggestion that the resin composition may be

molded into a textile product. There is no description or suggestion of using a linear poly-L-lactic acid of a specific relative viscosity for drawing into fibers and yarns.

The present invention was developed to meet a demand for a biodegradable fiber or yarn. Use of biodegradable synthetic resins such as polylactic acid for textiles is known. However, the use of the known biodegradable resins presents a serious problem, since the workability or processability of the known biodegradable resins including polylactic acid is low; such uses are not practical in industry. The properties of the textile products made therefrom, such as tensile strength and elongation, are inferior compared with non-biodegradable resins, such as polyesters and nylon. A practical process for producing polylactic acid textile products having physical properties comparable to non-biodegradable synthetic fibers has not hitherto been provided.

The present invention provides a process for producing from polylactic acid that is workable industrially and provides good processability of the fibers and yarn in post-processing steps, such as dyeing, weaving and knitting. The present invention is directed to using a specific polylactic acid that has (1) a linear structure, (2) an L-isomer content of at least 98 mol%, (3) an Sn content of 0 to 30 ppm, (4) a residual monomer content of 0 to 0.5% by weight, and (5) a relative viscosity η_{rel} of 2.7 to 3.9.

It has been found that:

(1) The presence of branched structure in polylactic acid adversely affects the workability or processability of fiber and yarn products made therefrom and the tensile strength of the fiber and yarns products (see paragraph [0011] of the specification).

(2) The level of D-isomer in the starting material affects the physical properties of the fiber and yarn products. In particular, if the L-isomer content is less than 95 mol%, the tensile strength of the resultant fiber or yarn is very low and the shrinkage in boiling water is very high. Thus, the resultant fiber or yarn is not of practical use. It has been found that the orientation-crystallization of a resin prepared from lactic acid

with an L-isomer content not less than 95 mol%, especially not less than 98 mol%, is surprisingly improved in the spinning and drawing steps leading to an increase the tensile strength of the fiber or yarn produced. (See, paragraph [0013] of the specification).

(3) The presence of the tin catalyst causes depolymerization in the spinning step and decreases the workability of the spinning process (paragraph [0014] of the specification).

(4) The residual monomer leads to reduction of heat resistance causing breakage in the spinning and drawing steps (see paragraphs [0016] and [0078] of the specification). This is not known.

(5) The viscosity reduction ratio (viscosity decrease rate defined in paragraph [0039] of the specification) is important for producing a polylactic acid fiber of yarn of high quality without breakage. It is found that when the relative viscosity is within the specified range, the viscosity decrease rate is minimized to provide polylactic acid fibers or yarns of high quality without breakage even in high speed spinning. (See, paragraphs [0018] to [0020] of the specification).

The present invention shows that polylactic acid with improved heat resistance and excellent spinning operability can be obtained by restricting the monomer content, reducing the amount of catalyst that remained. By selecting only linear poly-L-lactic acid with a specific relative viscosity provides the improved heat resistance and the excellent spinning operability. This is not described or taught by the JP10287735A reference. There is nothing in the JP10287735A reference that describes the need for using a linear poly-L-lactic acid with a specific relative viscosity. Following the description and teaching of the JP10287735A reference would not lead to the use of linear poly-L-lactic acid with the specific relative viscosity claimed. Applicant has shown that it is the linear poly-L-lactic acid claimed that can provide the improved heat resistance and excellent spinning operability that can provide fibers and yarns. Under the law, the burden of showing that the

JP10287735A reference provided the teaching for the present claimed invention has not been met.

B. Claims 9 and 10 were rejected as obvious in view of a combination of JP10287735A and Matsui et al, US 6,174,602.

The Examiner contends that JP10287735A describe the use of polylactic acid to form fibers, knitted materials and textiles. Reconsideration of the rejection is requested for the following reason.

A review of the JP10287735A reference shows that it describes the use of the poly-L-lactic acid for molding articles and textile products. Based on this description, it only suggests that the polylactic acid of the JP10287735A reference can be molded into a textile product. There is no description or teaching of how to obtain a polylactic acid with improved heat resistance and excellent spinning operability for producing fibers and yarns.

Matsui et al. describes a random co-polymerized polylactic acid polymer that is low in crystallinity for producing fibers. There is no teaching or suggestion that it is necessary to control the L-lactic acid content of the polylactic acid nor to ensure that it is the linear poly-L-lactic acid with a specific relative viscosity that provides an improved heat resistance and excellent spinning operability to provide fibers and yarns of superior quality as evidenced in Examples 1 to 9.

Examples 2-1 and 2-2 and Comparative Examples 2-1 to 2-5 in Table 2- demonstrate that if the Sn content in polylactic acid is more than 30 ppm, spinning is very difficult due to depolymerization of polylactic acid.

Examples 2-3 and Comparative Examples 2-6 to 2-9 in Table 2-2 demonstrate that if the residual monomer content is more than 0.5 % by weight, the spinning viscosity is greatly lowered leading to difficulties in spinning.

Examples 2-6 and Comparative Example 2-10 in Tables 2-3 and 2-4 demonstrate that if branched polylactic acid is used, spinning workability is lowered, fluffs are generated during drawing and the multifilament yarn produced has a much

reduced tensile strength. Further, with a low peak thermal stress temperature, there is a high degree of fatigue in dyeing.

Examples 2-6 and Comparative Example 2-14 in Tables 2-3 and 2-4 demonstrate the importance of the L-isomer content. Polylactic acid prepared from lactide having an L-isomer content of 92.6 mol% in Comparative Example 2-14 does not provide a multifilament yarn that is of practical use. The tensile strength is very low and the shrinkage in boiling water is very high, with a high degree of fatigue in dyeing. For this reason, the L-isomer content should be kept to at least 95 mol%, preferably at least 98 mol%.

Further, Examples 2-6 and 2-7 and Comparative Examples 2-11 and 2-12 in Tables 2-3 and 2-4 demonstrate that if the relative viscosity is higher or lower than the specified ranges, the spinning and drawing workability are low. The tensile strength of the fiber or yarn obtained is also much reduced and lower than the level of 3.5 cN/dtex desired.

There is nothing in the JP10287735A reference or the Matsui et al patent that suggests the use of the specific poly-L-lactic acid would lead to this improvement in the resulting fiber or yarn product. These results are surprising and unexpected. For this reason, it is believed that claims 9 and 10 cannot be regarded as obvious in view of in the JP10287735A reference alone, the Matsui et al patent alone or their combination.

C. Claim 11 was rejected as obvious in view of a combination of the JP10287735A reference, Matsui et al and Wellington Sears Handbook of Industrial Textiles.

Claim 11 is directed at a process of producing a multifilament yarn using the linear poly-L-lactic acid of the present invention. Reconsideration is requested.

The JP10287735A reference and the Matsui et al reference were discussed herein above. Neither of the references taught nor suggested that it is important to use a linear poly-L-lactic acid with at least 98% L-lactic acid, a Sn content of less


than 30 ppm, a residual monomer content of below 0.5% and a specific relative viscosity as useful for producing fibers and yarns of superior quality in an industrial process.

Wellington Sears describes a process for melt spinning polymers into fibers. It adds nothing to the teaching of the JP10287735A reference and Matsui et al. to arrive at a process for producing a multifilament yarn with the superior characteristics shown in Tables 2-1, 2-2, 2-3 and 2-4. Applicants have provided ample data supporting the superiority of the claimed process of claim 11 wherein a specific poly-L-lactic acid was utilized. The results are surprising and unexpected. The use of polylactic acids of the prior art had led to problems of workability and poor product quality. There were no teachings or suggestions in the prior art cited on how to provide a polylactic acid for producing fibers and yarns of superior quality. Therefore, the invention as claimed in Claims 5-11 cannot be regarded as obvious in view of the combination of Wellington Sears reference alone or in combination with the JP10287735A reference and Matsui et al.

It is believed that Claims 5-11 as amended are allowable and an early allowance is requested.

Respectfully submitted,

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